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METHOD AND COST OF MINING THE THICK FREEPORT COAL IN A SECOND WESTERN PENNSYLVANIA MINE

BY

J. W. PAUL AND H. TOMLINSON

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METHOD AND COST OF MINING THE THICK FREEPORT COAL IN A SECOND WESTERN PENNSYLVANIA MINE[1]

By J. W. Paul[2] and H. Tomlinson[3]

INTRODUCTION

This report is the second of a series of papers on coal-mining methods and costs which are being prepared by the U. S. Bureau of Mines for the purpose of placing before those interested in the industry a knowledge of the mining methods employed in this particular mine, and cost data on the several operations pertaining to removing the coal from the face into the railroad cars at the tipple with economy and safety.

The methods employed are influenced by the natural local conditions with respect to the thickness of overburden, frequency of local "wants," and the means employed for roof support and its control.

Mining costs are governed to a great extent by the selection of the method best adapted to the natural physical conditions of the property.

The purpose of this paper is to present a detailed description of the methods employed and the equipment used, with the results obtained in the operation of this mine in the thick Freeport bed on the northern end of the field, near the Allegheny-Butler county line in western Pennsylvania. It may be classed as a captive mine, as the largest portion of the product is consumed at the by-product plants of the parent company.

ACKNOWLEDGMENTS

Through the courtesy of the company's general manager of mines, and the cooperation of the officials of the mine studied, the details given herein have been made possible. This paper is printed with the approval of the responsible executive official of the company, who has checked the accuracy of the descriptions and data given.

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HISTORY

This mine was opened in 1915, since which date 5,945,505 tons of coal has been produced up to and including 1928. The Thick Freeport bed, which is being mined at this property and several adjoining properties, was first mined and used for boiling salt water about 1830. The actual development and explor tion of this coal bed did not get under way to any great extent until about 1900, but to-day it contains some of the largest producing mines in western Pennsylvania. At the time when this mine was opened, the company was already operating two mines adjoining the property on the north and east, so that the quality and character of the coal had been established.

GEOLOGY AND TOPOGRAPHY

The rocks in the mine area belong to the Conemaugh and Allegheny groups of the Carboniferous Age. The Allegheny group, of which the Thick Freeport is the top member, is the lowest of these groups. It outcrops on Bull Creek at a point about 3 miles northeast of the mine. The Conemaugh group, which is above the Thick Freeport, consists of shales, sandstones, limestones, and a number of thin coal beds. The outstanding geological landmarks are the Mahoning sandstone from 2 to 8 feet above the Thick Freeport bed and the Crinoidal limestone about 320 feet above, neither of which seem to present any problems of roof control in pillar operations. A generalized section of the measures above the coal is shown in Figure 1, which is a record of drill holes 14 and 15 put down on the west and east sides of the property, and gives a fair average of the overlying measures. Between the Mahoning sandstone and the coal is a dark sandy shale several feet thick and a cannel slate about 18 inches thick which form the immediate roof all over the mine. Howeve areas are frequently encountered known as "horsebacks" or "wants" where the cannel slate, top coal, and sometimes part of the bottom coal disappear. When the bottom coal is affected, the bony bed usually narrows down and is found between the coal and the dark sandy shale in these areas, which occasionally extend several hundred feet; the coal dips to the center of the affected area and is usually too thin for economic mining. While these areas seem to have no effect on the roof control, they are a source of added expense to the minin operations.

Figure 2 shows two detailed sections of the coal bed. Figure 3 is a section of a "horseback" or "want."

Faults, Dip.- There are no displacement faults in the coal, and the di averages about 1 1/2 per cent to the southwest, but is rolly, occasionally pitching 4 1/2 per cent for a short distance then flattening out to normal.

Floor.- The floor under the coal bed is a fire clay several feet thick which heaves very slightly in solid as well as in pillar work.

Water.- The mine may be termed damp. A small amount of water is being made in practically all working places, but there is not enough to interfere with the operations or to create an uncomfortable condition. During the high-water season in the spring of the year, an average of 3,160,000 gallons are

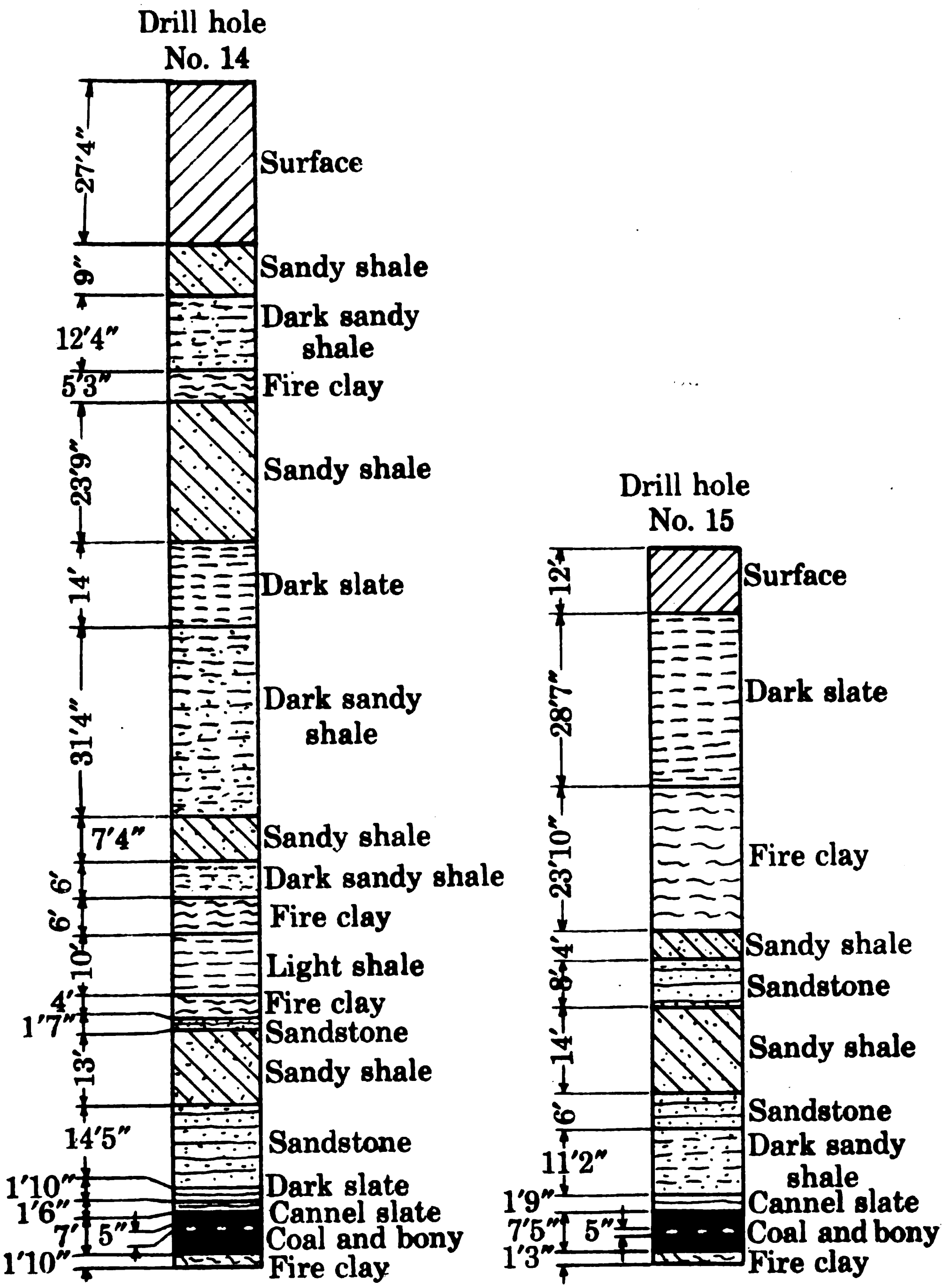
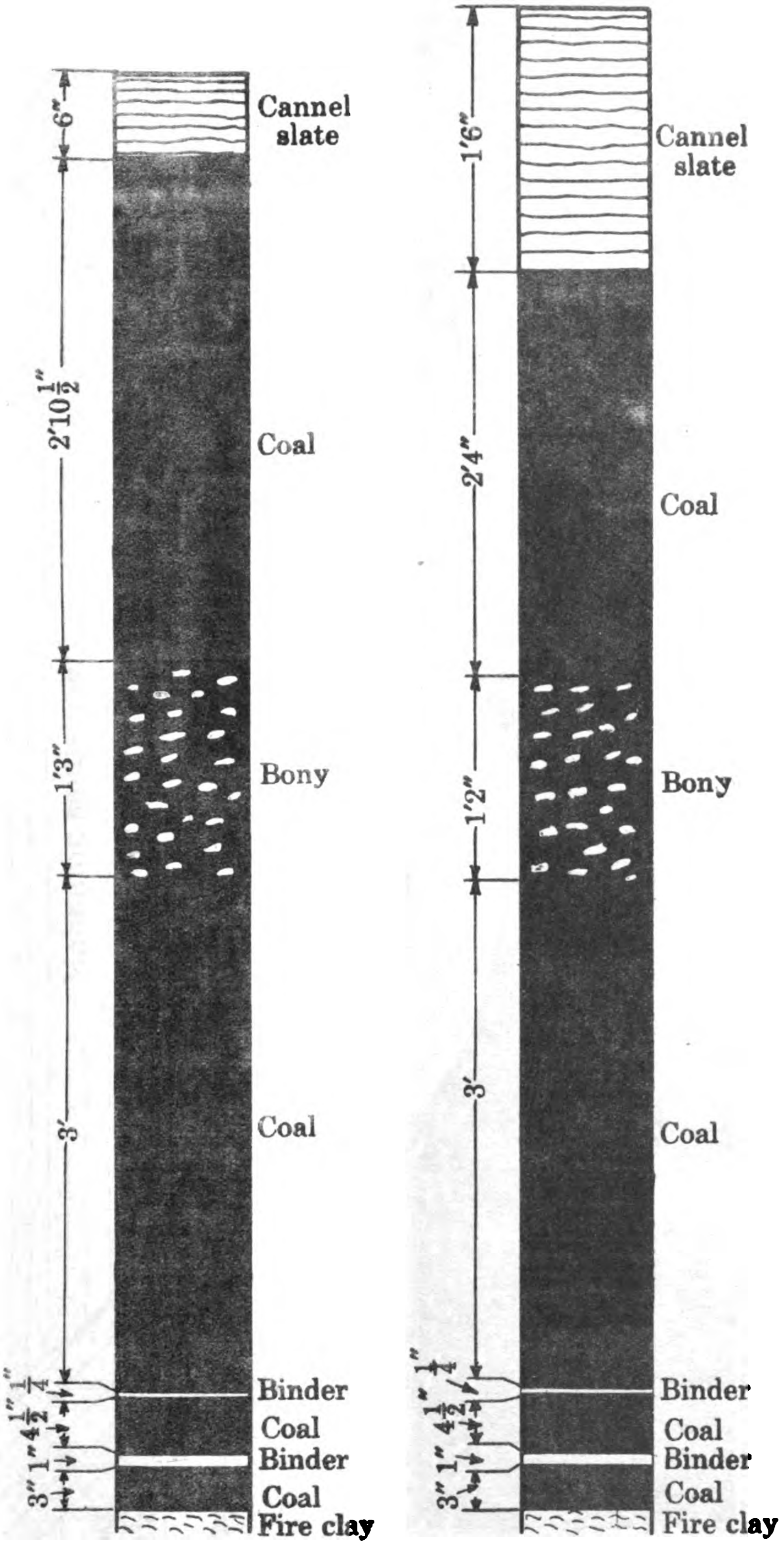


Figure 1.– Log of drill holes No. 14 on the west and No. 15 on the east



No. 6 room
No. 22 left butt
No. 8 face

No. 10 room
No. 27 right butt
No. 3 face S E.

Figure 2.— Typical sections of the coal bed and immediate roof

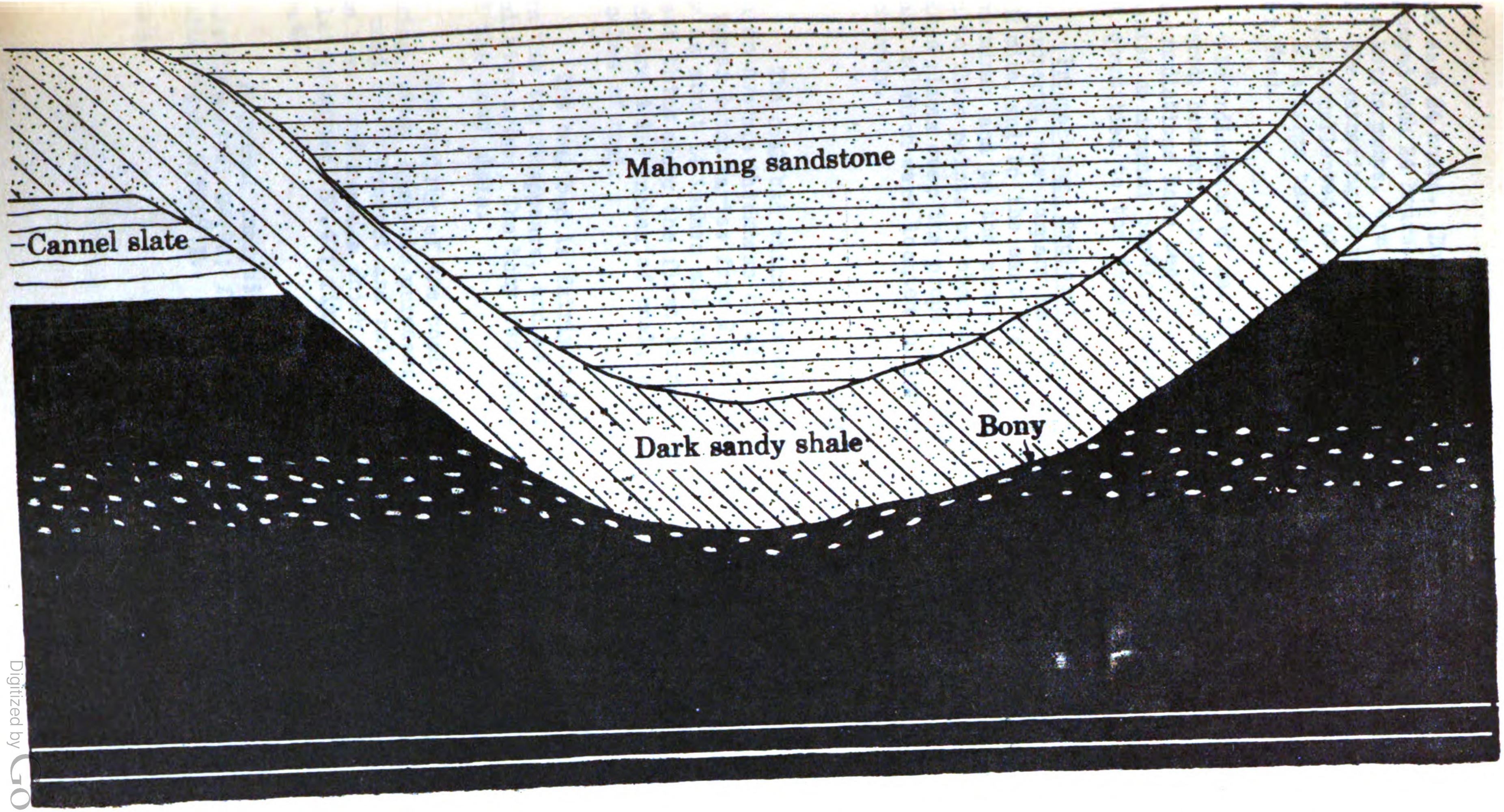


Figure 3.– Typical longitudinal section of a "washout", "want", or "horseback"

pumped each 24 hours. During low-water season an average of 924,000 gallons are pumped each 24 hours. Pumping to the surface is accomplished by two 600-gallon Morris pumps, one 400-gallon DeLaval pump, and two 160-gallon Deming pumps. The gathering is performed by twenty-six 2-inch gathering pumps. The drainage is collected at one main pumping station underground, whence it is pumped to a large tank on the surface, some of which is treated, and used for boiler feed.

No indication of gas pressure in the coal or adjacent strata has been discovered; however, in parts where the ventilation has been sluggish, small gas accumulations have been found. Therefore, the ventilation of this mine presented no unusual problems other than that of conducting the air in sufficient quantities to the faces.

Prospecting, Exploration, and Sampling.- Prior to the development of this property, the company had two other mines in operation - to the north the No. 2 mine, and to the east the No. 1 mine. On the west were several small wagon mines, and to the south a large captive mine was in operation. In addition to these points of observation a number of drill holes were put down at various places over the property. Figure 1 gives the record of drill holes 14 and 15 which were located on the west and east sides of the property, respectively.

COAL BED

The coal bed which varies from 7 feet 10 1/4 inches to 7 feet 3 inches, with an average thickness of about 7 feet 2 inches, has five distinct benches; the upper bench varies from 2 feet 10 1/2 inches to 2 feet 4 inches, and the bony is about 14 inches all over the mine. The bottom bench is uniformly about 3 feet thick above the first binder, which is one-fourth inch thick, below which are 4 1/2 inches of coal, a 1-inch binder known as the second band, and 3 inches of coal.

The coal bed is fairly uniform except where the want areas are struck; then the top disappears, and at times the bottom bench is affected. When this condition arises, the bony bed usually thins down and is found between the coal and the sandy shale.

The quality of the coal is such that it may be used for by-product coking, steam, domestic purposes, and gas. The major portion of this product is used for by-product and railroad fuel. An average analysis of coal from the Nos. 1 and 2 mines which adjoin this property is as follows: Moisture, 0.77; volatile matter, 37.47; fixed carbon, 58.18; ash, 4.35; sulphur, 0.69; B.t.u., 14,439.

A typical analysis of the bony band is as follows: Moisture, 0.91; volatile matter, 24.93; fixed carbon, 44.31; ash, 29.85; B.t.u., 10,730; fusion point of ash, 2,535° F.

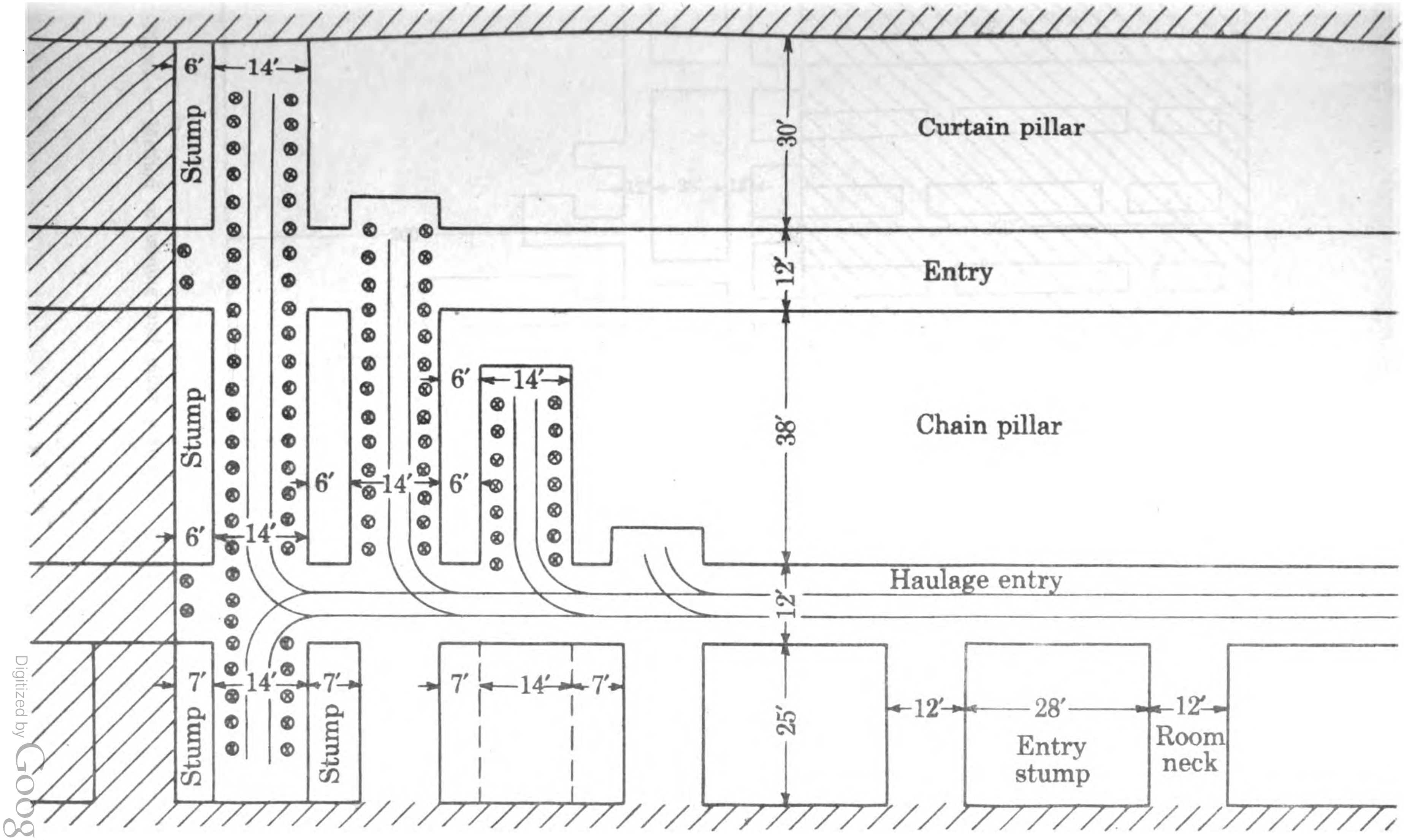


Figure 5.– Method of recovery of curtain pillar, chain pillar and entry stumps

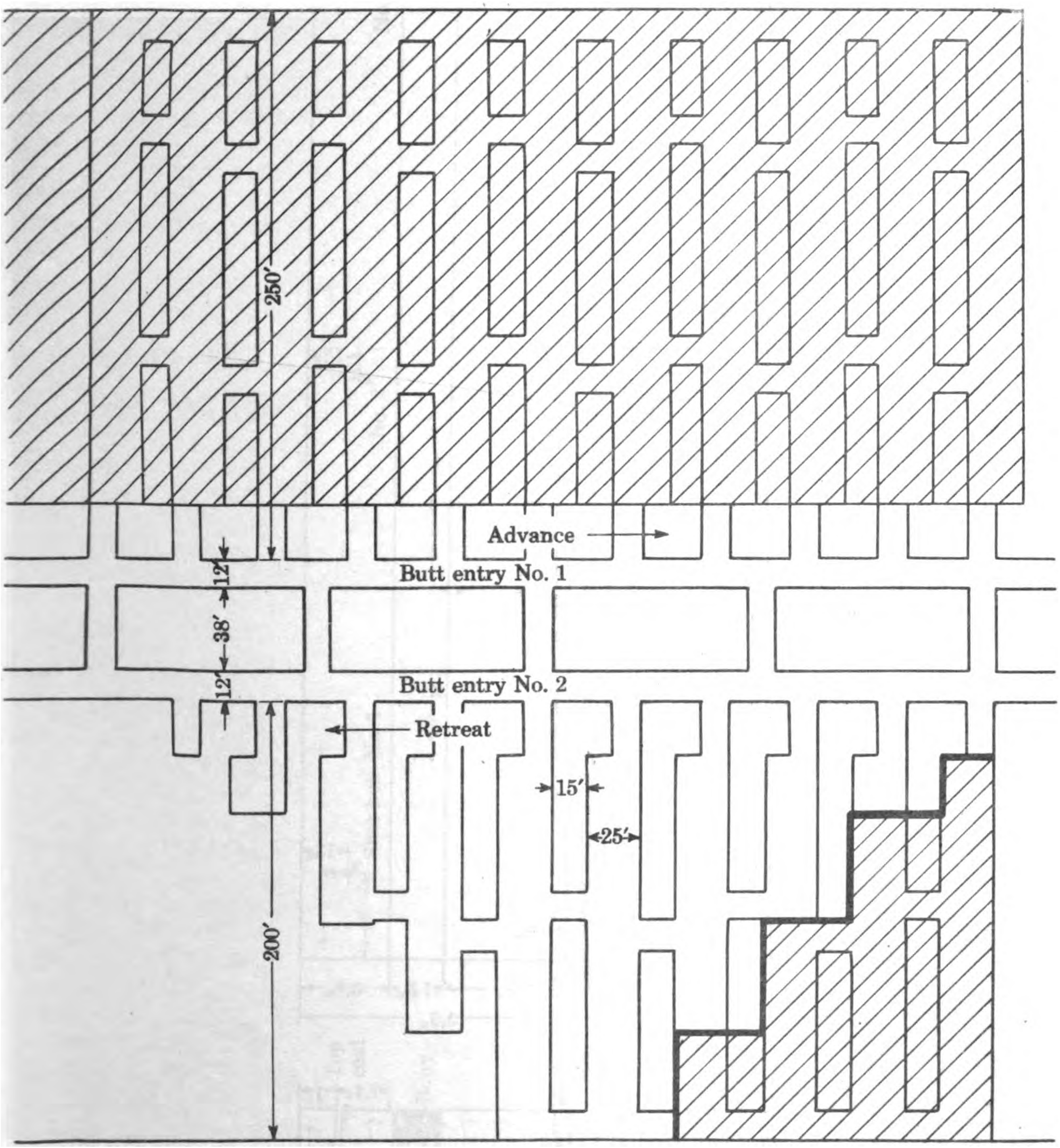


Figure 6.– Method of mining and pillar extraction; advancing and retreating on butt entries

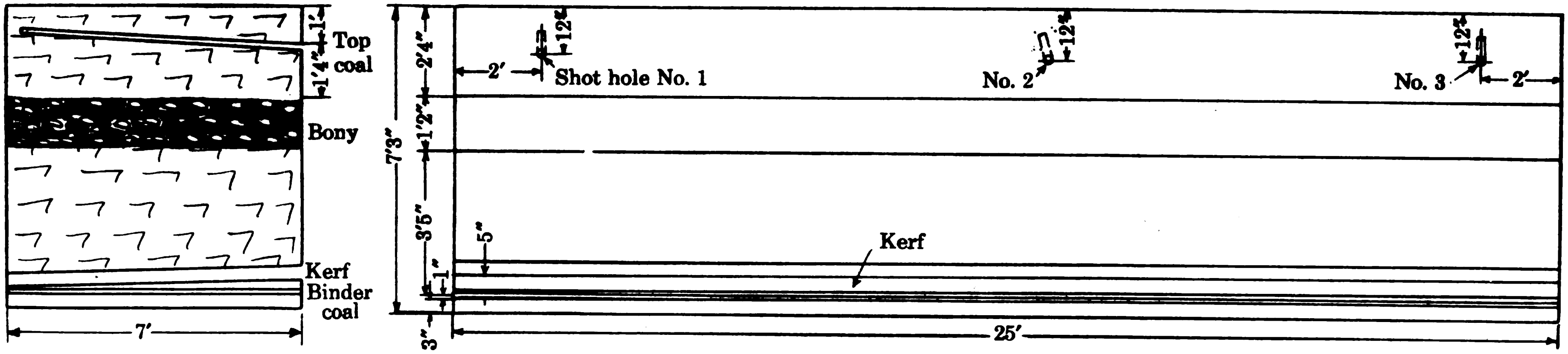


Figure 7.– Position of shot holes in rooms 25 feet wide, having an undercut 7 feet deep. Shots are fired in the order of Nos. 1, 2 and 3

face entries at intervals of 300 feet for single producing entries and of 450 feet for double producing entries. These butt entries were driven through to the next face entries, rooms 25 feet wide on 40-foot centers being turned as the entries advanced. In advance work on the single producing entries the rooms are driven 250 feet long and a 30-foot curtain pillar is left between the end of the room and the next butt entry (fig. 5). In advance and retreat on double producing entries the rooms are 250 feet long on the advance side and 200 feet long on the retreat side. The advancing rooms and retreating pillar faces are carried in a series of steps about 50 feet apart (fig. 6), which allows five rooms to advance and five pillars to retreat at the same time.

Owing to the easy manner in which the roof is controlled, no effort is made to carry long break lines, and each pair of butt entries has its own individual gob line.

Room necks turned off the butt entries are 12 feet wide and 25 feet long. When the room is driven up its distance, the ribs are immediately withdrawn; as the ribs are only two cuts or 15 feet in thickness, their recovery is accomplished rapidly. Recovery of the curtain and chain pillars and entry stumps, on the other hand, is a slow process, and often lags behind the room ribs several hundred feet, although there seem to be no ill effects due to crush or squeeze, which in itself shows the ease with which the roof is controlled.

B. (1) Mining.- All the coal except the small stumps left for protection in pillar work is mined by electrically driven machines of the shortwall type. There are eight of these machines, three of which are double shifted, all equipped with 7-foot cutter bars; for the 11 machine shifts they average about nine places cut each shift per machine, with an average of 271.72 tons per machine. Two men form the crew for each machine.

(2) Drilling and Blasting.- The shot holes for breaking down the coal are drilled with post augers by the miner. The auger is 1 3/4 inches in diameter, and the holes are drilled 6 inches shorter than the mining and about 2 feet from the rib. Three shot holes are used for each cut, as indicated in Figure 7. Shot holes Nos. 1 and 3 are placed about 2 feet from the rib and 1 foot below the roof. No. 2 is placed near the center of the face and is slightly inclined towards No. 1. All shots are inclined at an angle, so that the back of the hole is about 6 inches shorter than the mining and about 6 inches below the roof.

Shot No. 1 is fired first, using 4 to 5 sticks of permissible explosive. Two and a half to three sticks are used in No. 2, which is fired after the coal brought down by No. 1 is loaded out, and 2 to 2 1/2 sticks in No. 3. The shot holes are tamped to the collar with clay and fired by the section boss with a small single-shot battery. Explosives are furnished to the miners at the following rates: powder 7 cents per stick, and detonators 7 cents each.

The preparation of a good-sized, clean product is one of the features of this plant. Serious thought has been given and experiments have been made to arrive at the present blasting methods. The explosive used is in sticks 1 1/8 by 7 inches, weighing 3 1/2 ounces per stick. During 1928, 48,800 pounds of explosive were used to produce 511,879 tons of coal, or 1 pound of explosive for 10.49 tons.

The 14-inch bony band is separated from the coal by the miner, and in the rooms and pillars it is gobbed, whereas in the entries and narrow places it is loaded and sent out of the mine. The yardage is part of the compensation for loading this bony, and a bony car, being an extra car, is not counted.

(3) Rooms and Pillars.- Rooms are developed by advancing on the face cleats of the coal, except where a "horseback" or "want" area is struck or bad roof conditions are encountered; in such places the rooms are driven on the butt cleats. As shown in Figure 8, the pillars or ribs are withdrawn by making cuts 18 feet wide in the rib and leaving a 6-foot stump next to the caved area for protection. The ribs are 15 feet, or two cuts, through. After the coal is loaded from these two cuts, the stump left for protection is removed by pick work.

When these two cuts have been made and the coal has been recovered from the stump, break-line posts are placed near the edge of the new block. The operation is carried on in this sequence down to the room neck.

The development of the mine is so well advanced that all producing operations are on a single shift. In narrow work, 18 cents per yard is paid the cutters and 45 cents per yard is paid the loaders.

(4) Loading.- All loading of coal and refuse is done by hand. At the surface plant the coal is sized and hand-picked, and has a daily average production of 2,989 tons or approximately 10.1 tons per miner, 19.66 tons per dayman, and 271.72 tons per machine.

(5) Deadwork.- In addition to handling coal the loading price also includes compensation for the necessary drilling, blasting the shot holes, and cleaning the coal, such as is the general practice in this field. This involve the care of roof and its support in the working places; laying of track for loading, except curves and switches; and handling the car from the entry to the face.

In addition, extra compensation is paid for clay veins and spars according to the schedule given in the table on page 14. Extra expense on deadwork is involved where the "horseback" or "want" areas are encountered on entries o haulageways; often the upper bench and sometimes part of the lower bench of coal is missing which requires these entries to be driven partly through rock. Where "wants" appear in rooms, the room is worked to the point where it is unprofitable and then abandoned. It is estimated that 13 per cent of the coal is lost due to these "want" areas - 5 per cent in pillars that are left under surface streams and 3 per cent in pillar stumps and barriers around oil wells and boundary lines.

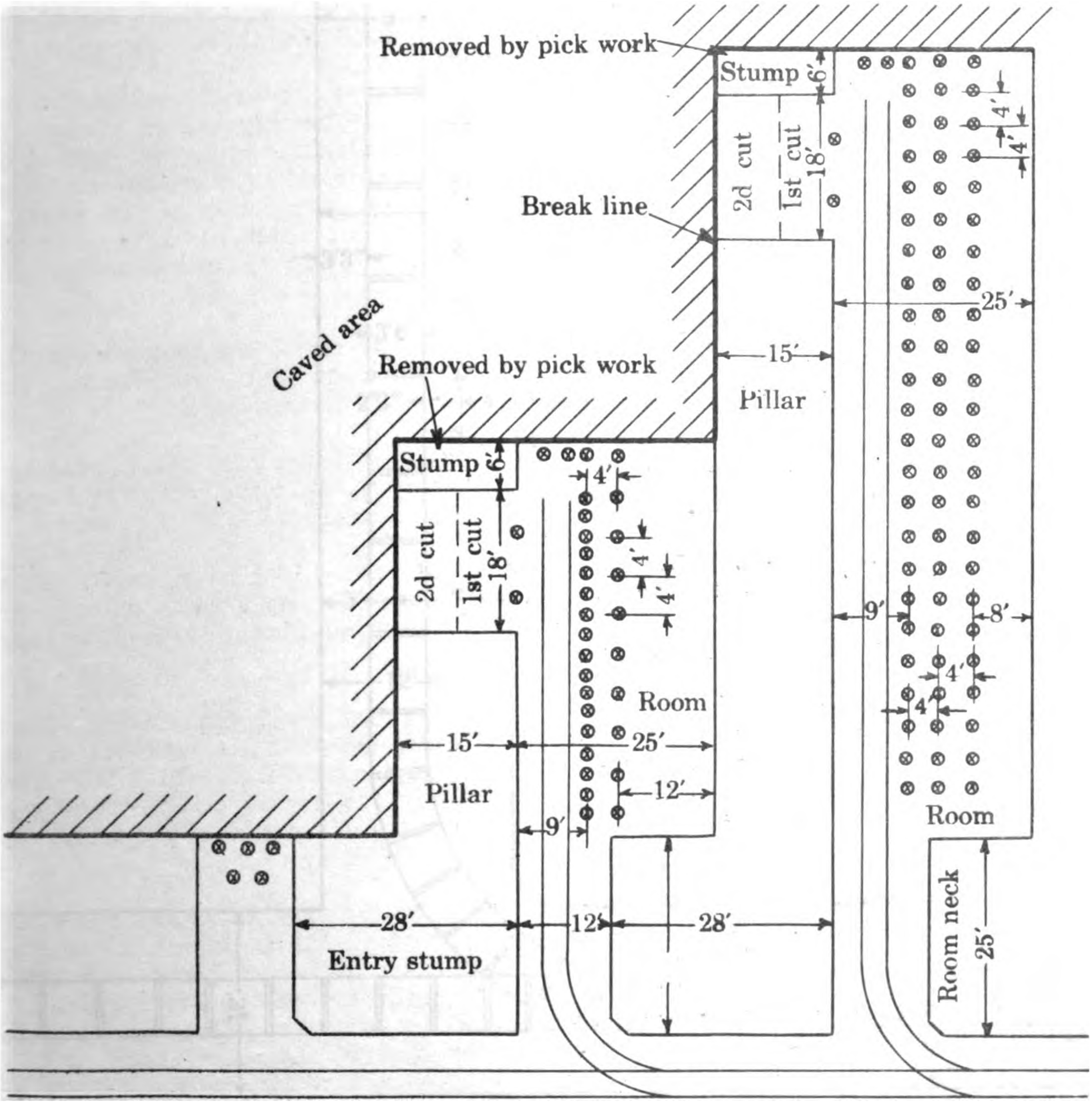


Figure 8.— Sequence of operations in removal of room pillars, position of posts

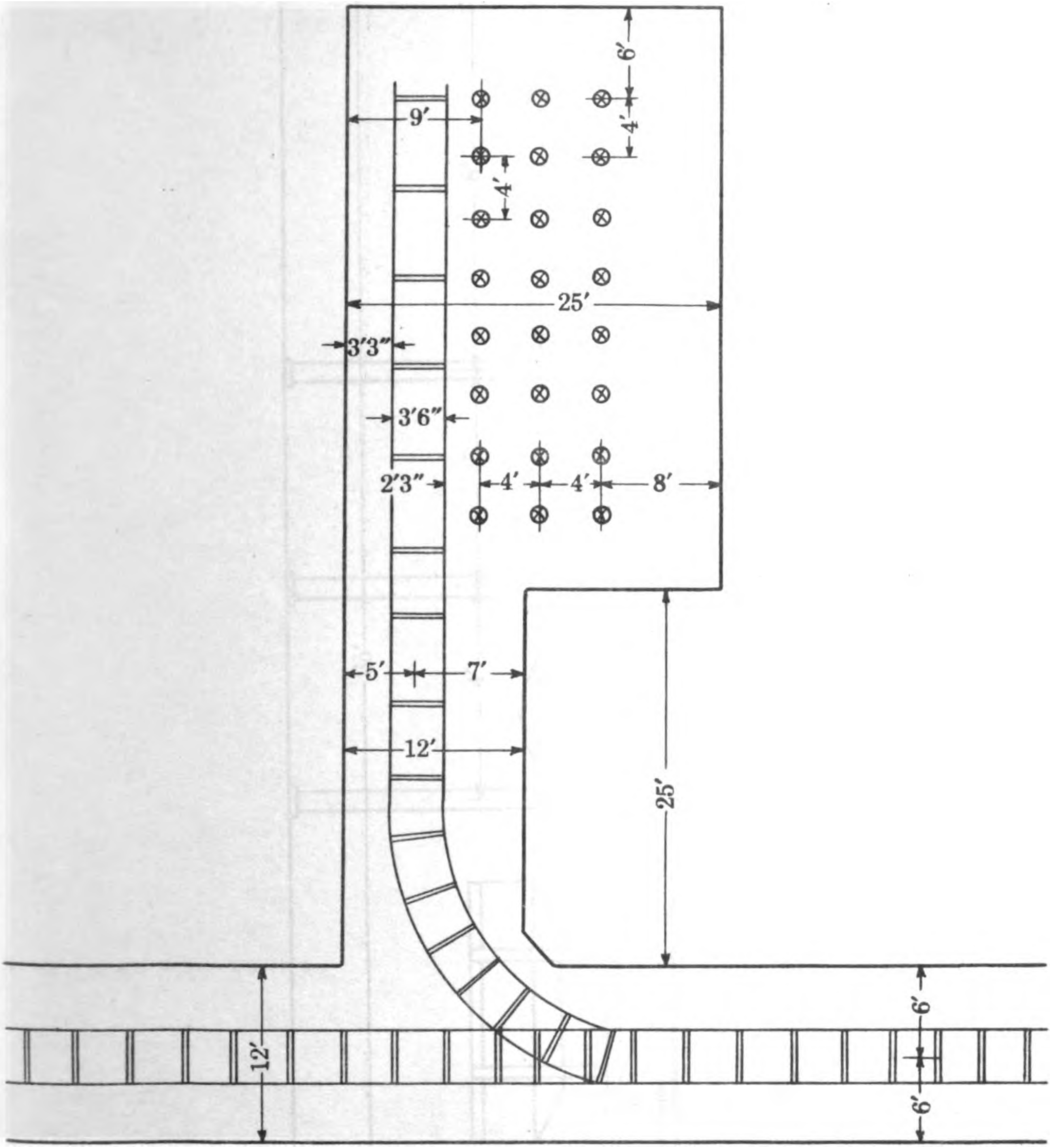


Figure 9.– Position of track and posts in a room 25 feet wide

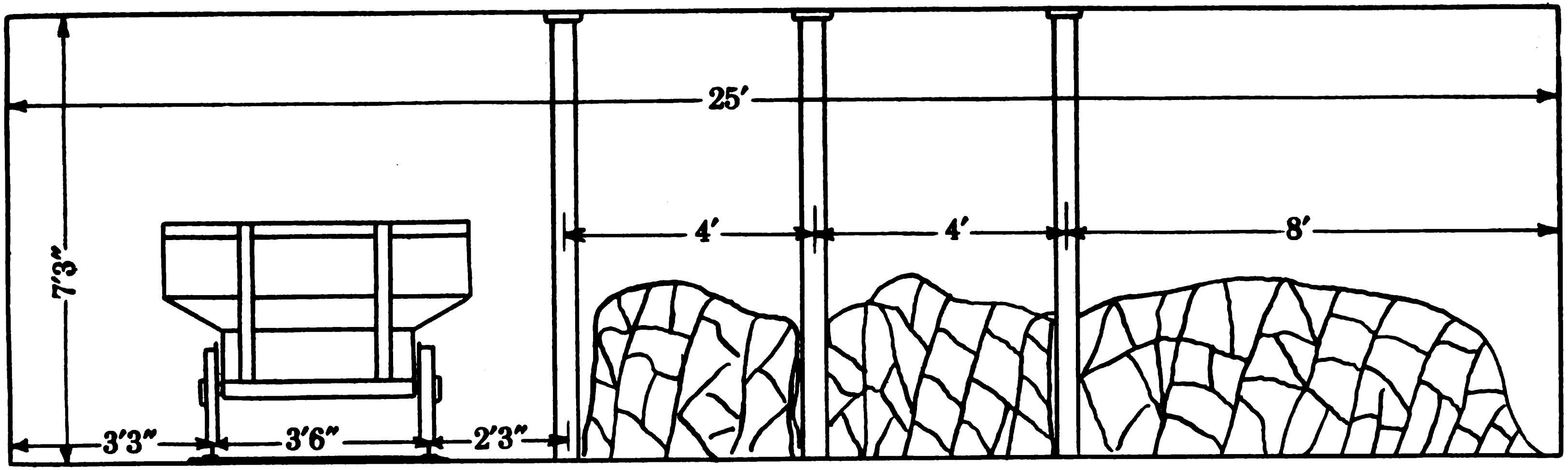


Figure 10.– Cross section of room 25 feet wide, showing position of track, rows of posts, and gobbed refuse

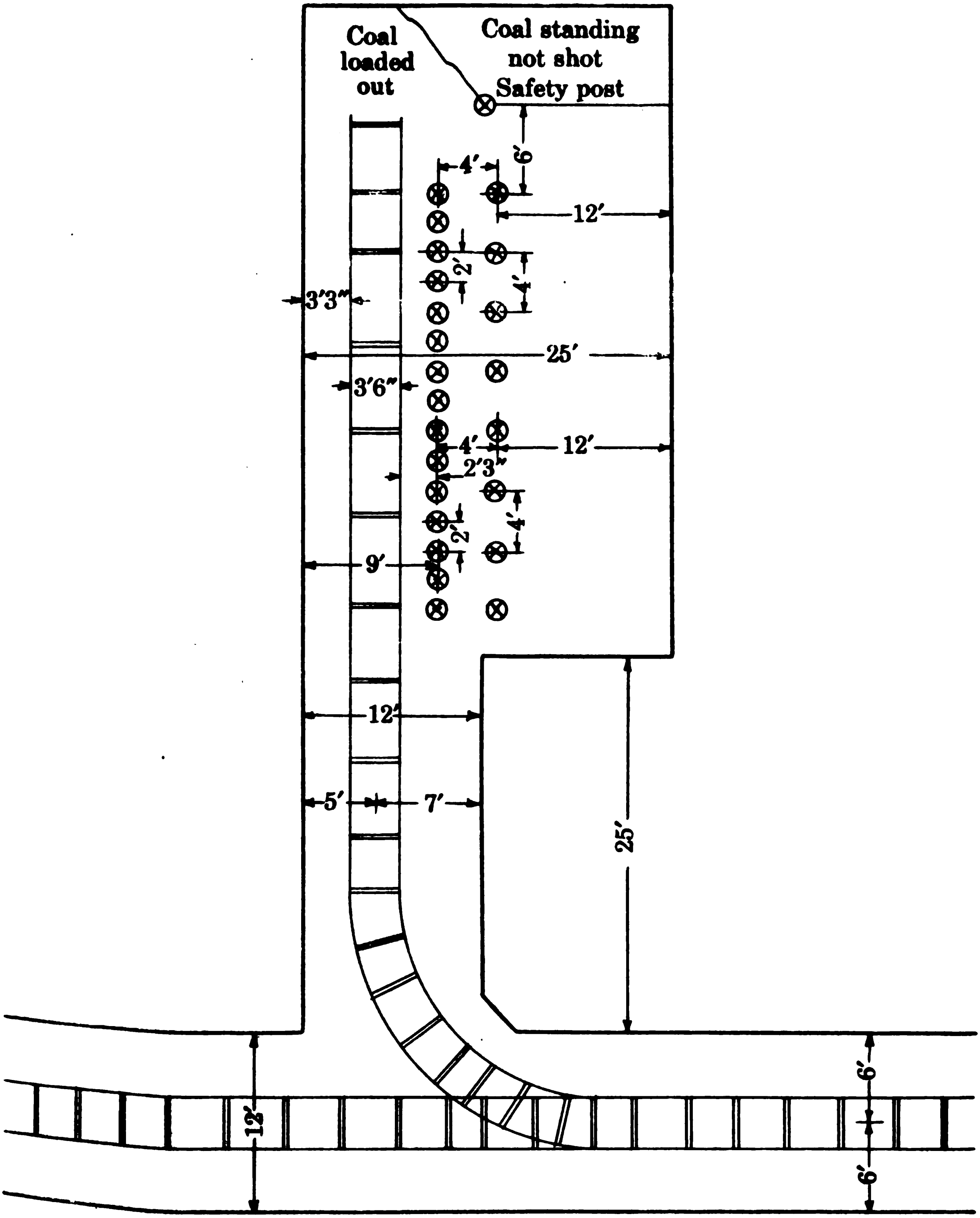


Figure 11.– Plan of room 25 feet wide, showing position of track, two rows of props, and safety post

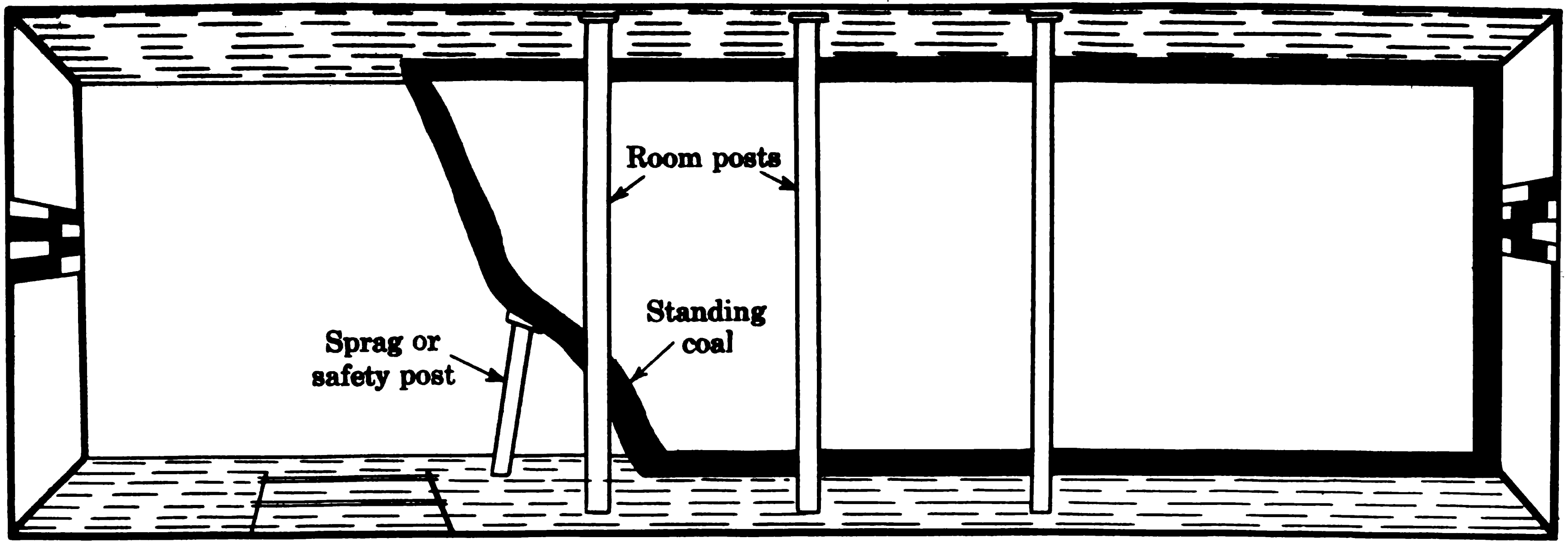


Figure 12.— Position of a sprag or safety post at the face of standing coal while coal from the breaking-in shot is being loaded

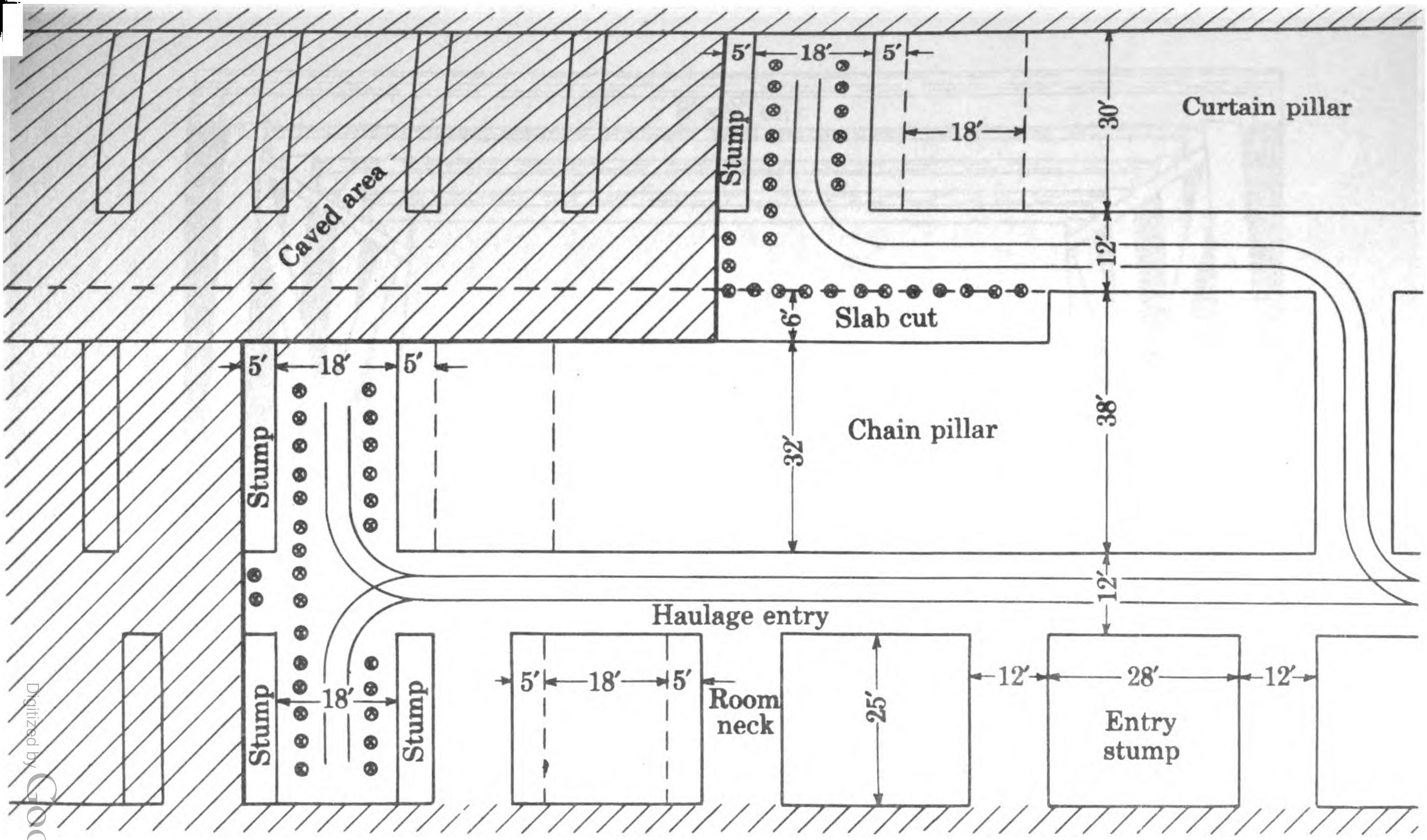


Figure 13.– Removal of curtain and chain pillars and entry stumps in butt entries from which rooms are developed on one side only

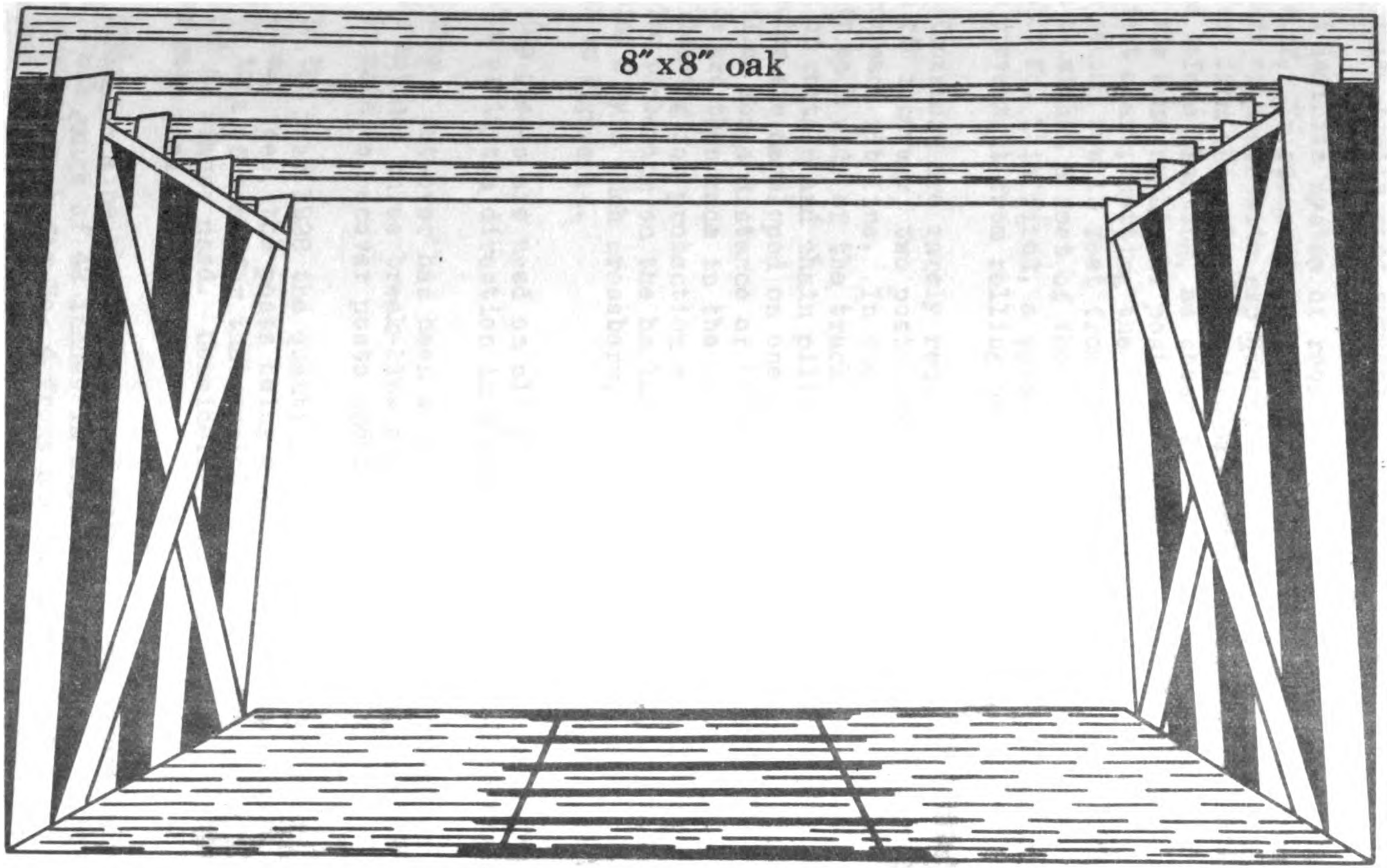


Figure 14.– Square sets of timber with cross bracing as installed at places on the main haulage entries

(6) Timbering.- The immediate roof consists of cannel slate 18 inches thick. This forms a good roof all over the mine and rarely needs support. However, where roof support has been required it has been furnished in the shape of I-beams, 40 and 60 pound rail, and 8 by 8 inch square sets, but, as a general rule, little roof support is required on the entries and haulageways.

A definite system of roof support has been adopted for the room-and-pillar work. In rooms 25 feet wide two methods are in use; the first requires three rows of posts with cap pieces placed on 4-foot centers, setting the first row 9 feet from the rib on the track side and carrying it to within 6 feet from the face before blasting, as shown in Figures 9 and 10; the second method employs the same number of posts as the first method but places them in two rows 4 feet apart, setting the first row 9 feet from the rib on 2-foot centers and the second row 13 feet from the rib on 4-foot centers. Both rows are carried to within 6 feet of the face before blasting, as shown in Figure 11. After shot No. 1 is fired, a sprag or safety post is placed to the standing coal to prevent it from rolling over (fig. 12).

Crossbars are rarely required in rooms or pillars. When a cut-over is made in rib recovery, two posts are placed in line with the rib and about 4 feet from each rib line. In the entry stump-recovery work, a row of posts is placed on each side of the track on 4-foot centers. Figure 13 is a plan of removal of curtain and chain pillars and entry stumps in butt entries from which rooms are developed on one side only. A slab cut is first made in the chain pillar for a distance of 50 feet by a cutting machine. Cut-throughs 18 feet wide are then made in the curtain pillar, the chain pillar, and entry stumps, leaving for protection a 5-foot stump, which is later removed by pick work. The timbering on the haulage roads consists of 8 by 8 inch oak posts supporting 8 by 8 inch crossbars, and it is the practice to cross-brace the post as shown in Figure 14.

Cap pieces are used on all posts, but there is no uniformity in their dimensions or in the direction in which they are placed on the post.

When a cut-over has been worked out and the protection stump drawn, two and sometimes three break-line posts are set with large cap pieces. No attempt is made to recover posts under any condition.

In the year 1928 the quantity of timber used for roof support was 381,925 linear feet, the posts being 6 and 7 feet long. Based on a production of 511,879 tons of coal for that period, 1.34 tons of coal was produced per linear foot of timber used. Considering the posts alone, 8.34 tons wereproduced per post used.

Haulage.- Mine tracks, size of trip, and equipment have been standardized. A track gauge of 42 inches is used. The standard radii of curves and switches are 100 feet for No. 4 frogs and 150 feet for No. 6 frogs on main haulage, and on room turnouts 16 feet 9 inches for curves with a No. 1 1/2 frog, as shown in Figure 15.

Rails are 60 pounds on the main haulageway, 40 pounds on the face entries, and 20 pounds on butt entries and rooms. The main haulage tracks are kept graded and on line to insure the efficiency of the haulage system.

Room tracks are placed and maintained by the miners, all turns and switches being laid by daymen. Ties 5 inches by 7 inches by 6 feet long on 24-inch centers are used on main haul and face entries. These main haulage tracks are kept on the center line of the entry and allow about 4 feet clearance from either rail.

Gathering locomotives deliver the cars to the room neck, from which point the miner pushes them to and from the face, excepting where the grade is against the load, when the cars are hauled from the face by the crab reel attached to the gathering locomotive. There are 12 of these crab-reel gathering locomotives of the 6-ton type in operation.

Table 1 shows an average day's work on December 20, 1928, of the 12 crab-reel-type 6-ton gathering locomotives:

Table 1.- Movements of 12 Crab-Reel 6-Ton Gathering Locomotives

Main haul motor No.	Gathering motor No.	Average length of haul, miles	Loads hauled	Miners served	District operating
1	4	0.27	121	24	2 Face NW.
1	12	0.27	120	25	5 Face NW.
1	14	0.28	134	28	Main north.
2	2	0.42	124	24	13-15 Left 17. Right 8 face SE.
2	5	0.23	103	20	9-10 Left 9 butt. 8 Face SE.
2	13	0.23	121	24	19 Left faces 8 face.
3	3	0.17	127	28	15-16 left SE. 5 Face SE.
3	7	0.13	105	29	17 Right face 8 Face SE.
4	1	0.15	120	20	28 Right 29 left dips.
4	6	0.25	111	25	21-23 Left dips.
4	8	0.17	120	28	23-25 Right 25 left dips.
4	11	0.28	113	21	27-28 Left dips.
Total	-	-	1,419	296	-

No. cars of coal hauled, 1,324.
No. cars of refuse hauled, 85.
Total cars hauled, 1,419.
Tonnage. . . . . . . 2,989 tons.
Miners 296

The average number of cars gathered per gathering locomotive on this average day was 118.25, carrying 266 tons of coal, and each locomotive served an average of 24.66 miners.

The foregoing table shows that 1,419 cars were gathered from the miners on this average day, 1,324 of which were coal and 85 refuse. On being gathered from the room necks, the loads are deposited at a common point near the face entry, where they are picked up by the main haul locomotive.

The length of haul for the gathering locomotives varies from 700 to 2,200 feet. No secondary or intermediate haulage is employed in this mine.

From the points mentioned to the shaft is the main haulage on which four 13-ton locomotives haul 30 car trips to the shaft, all directed by a dispatcher at the shaft bottom. Table 2 gives the number of cars hauled by each locomotive on December 20, 1928, which was an average day's operation:

Table 2.- Average Day's Work of Main-Haulage Locomotives

Locomotive No.	Average length of haul, miles	No. loads hauled	No. men served
No. 1, main west	0.97	375	77
No. 2, 8 face SE.	1.44	348	68
No. 3,[1] 5 face SE.	1.26	232	57
No. 4, 2 face SE. dips	1.09	464	94
Total		1,419	296

[1] No. 3 is operated by one man.

During this shift the four main-haulage locomotives hauled 1,419 loads to the shaft and 1,419 empties from the shaft, an average of 354.75 loads, or approximately 798 tons, and 354.75 empties per locomotive on main haulage.

Table 3 has been compiled to show the ton-miles of work accomplished by the main-haulage locomotives on December 20, 1928, which has been used as the average day for this study. The average weight of coal in the car for this day, when 1,324 cars were dumped and weighed at the shaft with a total tonnage of 2,989 tons, was 2.25 tons. The weight of the empty car is 1 ton. The length of the haul from the main west where No. 1 locomotive operates is 0.97 miles. The locomotive hauled 375 loads and 375 empties, accomplishing 1,182 and 364 ton-miles of work, respectively, or a total of 1,546 ton-miles of work. The length of the haul from 8 Face SE. where No. 2 locomotive operates is 1.44 miles. The locomotive hauled 348 loads and 348 empties, accomplishing 1,628 and 501 ton-miles of work, respectively, or a total of 2,129 ton-miles of work. The length of the haul from 5 Face SE. where No. 3 locomotive operates is 1.26 miles; 232 loads and 232 empties were hauled, accomplishing 948 and 292 ton-miles of work, respectively, or a total of 1,240 ton-miles of work. One man only is used as the crew on this haul. The length of the haul from the dips or 2 Face SE. where No. 4 locomotive operates is 1.09 miles; 464 loads and 464 empties were hauled, accomplishing 1,642 and 505 ton-miles of work, respectively, or a total of 2,147 ton-miles of work.

This shows that 5,400 ton-miles of work were required to haul a total of 1,419 loads to the shaft, and 1,662 ton-miles were required to haul 1,419 empties from the shaft; therefore a total of 7,062 ton-miles of work were accomplished on the main haulage system to produce 2,989 tons of coal and to haul 85 cars of refuse to the shaft.

Table 4 furnishes a detail of the ton-miles of work performed on the gathering haulage system, showing that in gathering 1,419 loads and distributin 1,419 empties, 1,101 and 338.8 ton-miles of work, respectively were accomplishe or a total of 1,439.8 ton-miles of work.

A total of 7,062 ton-miles of work on the main haulage system and of 1,439.8 ton-miles of work on the gathering haulage were accomplished, making a total of 8,501.8 ton-miles of work to produce 2,989 tons of coal, or 2.85 ton-miles of work on the haulage system per ton of coal produced.

Mine Cars.- At this plant there are 700 mine cars that carry an average load of 2.25 tons. They are of wood and are equipped with end gate and 18-inch wheels with plain bearings.

During the shift of December 20, 1928, 1,324 cars of coal and 85 cars of refuse were hoisted at the shaft, or a turn-around was made on 700 mine cars of nearly 2.03 times for each car.

Drainage, Pumps - Type and Capacity.- This mine may be called damp, although there is no excessive amount of water being made at any one particular point. All places seem to be damp. The natural drainage of the mine is to the southwest, and No. 1 SW. faces, not operating at this time, furnish an ideal storage whence the water is pumped to a sump at the shaft bottom. From this sump the water is pumped to the surface by two Morris pumps of 600-gallon capacity and one DeLaval of 400-gallon capacity. During low-water season the pumping is done on the off shift to balance the power load. The labor and material cost for drainage is .0147 and .0504 per cent, respectively, of the total labor and material costs.

Ventilation.- The ventilation is supplied by a 16 by 6 foot fan direct-driven by a 22 by 24 inch steam engine at 100 pounds pressure, furnishing 160 hp. and exhausting 160,000 cubic feet of air per minute against a 1 1/2-inch water gauge.

There is a good supply of air at the working faces. Where necessary, line brattices are used to conduct the air to the face. Doors are constructed of 1 by 12 inch lumber doubled and are hung to close with the air current. Stoppings are built of hollow tile or concrete blocks as the entries advance. Overcasts are built with hollow tile walls, and concrete with rails for reinforcement is employed for the tops. Occasionally bricks are placed in the flanges of the rails and plastered over to form the top in place of concrete. The air courses are free from falls due to the good roof the cannel slate makes.

Table 3. - Ton-miles of work accomplished by main-haulage locomotives, December 20, 1928.

	Locomotive No. 1				Locomotive No. 2				Locomotive No. 3				Locomotive No. 4				Total cars	Total ton-miles
	Cars	Ton-miles load	Ton-miles empty	Total ton-miles	Cars	Ton-miles load	Ton-miles empty	Total ton-miles	Cars	Ton-miles load	Ton-miles empty	Total ton-miles	Cars	Ton-miles load	Ton-miles empty	Total ton-miles		
Main West:																		
Average length of haul, 0.97 miles																		
Loads	375	1182	-	-	-	-	-	-	-	-	-	-	-	-	-	-	375	1182
Empties	375	-	364	-	-	-	-	-	-	-	-	-	-	-	-	-	375	364
Total ton-miles work	-	-	-	1546	-	-	-	-	-	-	-	-	-	-	-	-	-	1546
8 Face SE.:																		
Average length of haul, 1.44 miles																		
Loads	-	-	-	-	348	1628	-	-	-	-	-	-	-	-	-	-	348	1628
Empties	-	-	-	-	348	-	501	-	-	-	-	-	-	-	-	-	348	501
Total ton-miles work	-	-	-	-	-	-	-	2129	-	-	-	-	-	-	-	-	-	2129
5 Face SE.:																		
Average length of haul, 1.26 miles																		
Loads	232	-	-	-	-	-	-	-	232	948	-	-	-	-	-	-	232	948
Empties	232	-	-	-	-	-	-	-	232	-	292	-	-	-	-	-	232	292
Total ton-miles work	-	-	-	-	-	-	-	-	-	-	-	1240	-	-	-	-	-	1240
2 Face SE. (dips):																		
Average length of haul, 1.09 miles																		
Loads	464	-	-	-	-	-	-	-	-	-	-	-	464	1642	-	-	464	1642
Empties	464	-	-	-	-	-	-	-	-	-	-	-	464	-	505	-	464	505
Total ton-miles work	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2147	-	2147
Total loads hauled to shaft	375	-	-	-	348	-	-	-	232	-	-	-	464	-	-	-	1419	5400
Total empties hauled from shaft	375	-	-	-	348	-	-	-	232	-	-	-	464	-	-	-	1419	1662
Total ton-miles of work	-	-	-	1546	-	-	-	2129	-	-	-	1240	-	-	-	2147		

Average weight coal, 2.25 tons: Weight of car, 1 ton.

Table 4.- Ton-miles of work performed in gathering haulage, December 20, 1928.

	Motor No.	Cars	Ton-miles load	Ton-miles empty
2 Face NW.	4			
Length of haul, 0.27 miles				
Loads	-	121	106	-
Empties	-	121	-	32.6
Total ton-miles work	-	-	138.6	-
5 Face NW	12			
Length of haul, 0.27 miles				
Loads	-	120	105	-
Empties	-	120	-	32.4
Total ton-miles work	-	-	137.4	-
Main north	14			
Length of haul, 0.28 miles				
Loads	-	134	122	-
Empties	-	134	-	37.5
Total ton-miles work	-	-	159.5	-
13-15 Left, 17 right, 8 Face SE.	2			
Length of haul, 0.42 miles				
Loads	-	124	169	-
Empties	-	124	-	52.1
Total ton-miles work	-	-	221.1	-
9-10 Left, 9 butt, 8 face SE.	5			
Length of haul, 0.23 miles				
Loads	-	103	77	-
Empties	-	103	-	23.6
Total ton-miles work	-	-	100.6	-
19 Left faces, 8 face SE.	13			
Length of haul, 0.23 miles				
Loads	-	121	90	-
Empties	-	121	-	27.8
Total ton-miles work	-	-	117.8	-
15-16 Left, 5 face SE.	3			
Length of haul, 0.17 miles				
Loads	-	127	70	-
Empties	-	127	-	21.5
Ton-miles work	-	-	91.5	-
17 Right, 5 face SE.	8			
Length of haul, 0.13 miles				
Loads	-	105	44	-
Empties	-	105	-	13.6
Total ton-miles work	-	-	57.6	-
28 Right, 29 left, dips	1			
Length of haul, 0.15 miles				
Loads	-	120	59	-
Empties	-	120	-	18
Total ton-miles work	-	-	77	-
21-23 Left, dips	6			
Length of haul, 0.25 miles				
Loads	-	111	90	-
Empties	-	111	-	27.7
Total ton-miles work	-	-	117.7	-
23-25 Right, 25 Left, dips	8			
Length of haul, 0.17 miles				
Loads	-	120	66	-
Empties	-	120	-	20.4
Total ton-miles work	-	-	86.4	-
27-28 Left, dips	11			
Length of haul, 0.28 miles				
Loads	-	113	103	-
Empties	-	113	-	31.6
Total ton-miles work	-	-	134.6	-
Total loads gathered				
Total empties gathered				
Total ton-miles work				

Average weight load, 3.25 tons: coal 2.25 tons, car 1 ton. Weight of empty, 1 ton. Average number cars per gathering motor per shift, 118.25. Average number miners per gathering motor, 24.66. Average tonnage per motor including refuse, 266 tons.

Power; Source of Supply, Kind, and Voltage.- Power is generated at this mine by six 200 hp. return tubular boilers which supply steam at 125 pounds pressure to three steam-driven engines direct-connected to three 200 kilowatt generating units, furnishing 250 volts d.c., which is the voltage used in the mine.

Tabulation of Data.- Tables have been prepared giving the scale of wages, mining, deadwork, and day labor rates, classification of labor, and operating cost percentages, to which the following explanations apply:

1. The scale of wages, mining and day labor, gives the contract price for cutting, loading machine coal, pick coal, and contract rates on deadwork on a yardage basis, also the daily rate of other employees according to their classification.

2. The classification of labor gives the percentage of men employed at the various classes of work, such as contract labor - miners and cutters - inside daymen, haulagemen, and outside day labor.

3. Operating cost percentages for labor and material are included under the items of mining, haulage, timbering, ventilation, tipple, drainage, deadwork, power, and mine office. The charges contained in these items are:

Mining.- Cost of labor and supplies for loading, cutting machine boss, bit sharpening, pick mining, yardage, and shot-firer supplies.

Haulage.- Cost of gathering and hauling coal, operating and maintaining mine roads and tracks, lifting track and bottom coal, cleaning tracks, dispatcher cagers, hoist engineers, motor barn, and repairs and supplies.

Timbering.- Cost of labor and supplies for timbering.

Ventilation.- Cost of labor and supplies for bratticing, stoppings, doors, overcasts, fire bosses, and maintenance of ventilating system.

Tipple.- Cost of operation of tipple and preparation plant, scales, weigh boss, repairs, and supplies.

Drainage.- Cost of operating drainage system, pumps, and pipe lines.

Deadwork.- Cost of drilling and loading rock through "want" areas, clay veins or spars, bony dumpers, bony tipple, repairs, and supplies.

Power.- Cost of manufacture and repairs of generating equipment, power lines, filter plant, electricians, power house, repairs and supplies.

Mine office.- Cost of supervision, sightman, coal inspector, clerks, electric lamps, telephones, policing, fire and rescue equipment, teamster and trucks, handling supplies, repairs and supplies for these items.

The following wage scale and conditions apply from April 1, 1928:

Tonnage Scale

Pickmen	$0.75
Loaders with hand drilling	.59
Cutters	.11
Cutters - Entry yardage	.18
Loaders - Entry yardage S.S.	.45

Chain Machine - Deadwork

Clay vein (Over 6 in. less than 12 in., $2.23; (cutter, $0.39; loader, $1.84.

Clay vein Over 12 in., $2.23 per foot; cutter, $0.39; loader, $1.84.

Clay vein Angle, $0.53 per yd.; cutter $0.08; Loader $0.45.

Spar - Less than 6 in., $1.09; cutter, $0.20; loader, $0.89.

Spar Angle, $0.26 per yd.; cutter, $0.06; loader, $0.20.

Entry yardage applies to places 12 feet wide or less.
In places over 12 feet wide and less than 18 feet wide, three-fourths entry yardage will apply.
Places 18 feet wide and over will be considered wide work.
All break through yardage will be applied on above basis.

Inside Day Wage

Cager at coal shaft	$6.25
Cager's helper	6.00
Car pushers	5.80
Car couplers	5.80
Car spraggers	5.80
Car oilers	5.80
Check puller	4.50
Cager at main shaft	5.80
Motormen	6.10
Snappers	6.00
Dispatcher	6.00
Trappers	4.50
Tracklayers	6.00
Tracklayers' helpers	5.80
Pumpers	5.60
Bratticemen	6.00
Bratticemen's helpers	5.80
Wiremen	6.00
Wiremen's helpers	5.80
Pipemen	6.00
Pipemen's helpers	5.80
Road cleaners and other inside labor	5.80

Outside Day Wage

Blacksmith	$6.40
Blacksmith's helper	5.40
Bit sharpener	5.40
Carpenter	6.40
Car repairmen	5.40
Lampmen	5.40
Firemen	5.60
Ash Wheeler	5.11
Filter plant attendant	5.60
Coal inspector	5.20
Top cager	5.20
Dumper	5.20
Car pushers	5.11
Loading boom operator	5.20
Car trimmers	5.11
Car droppers	5.11
Car cleaners	5.11
Bony picker	4.75
Bony motorman	5.20
Bony motorman's helper	5.11
Supply men	5.11
Supply cager	5.11
Other outside labor	5.11

Classification of Labor

Inside	Per cent
Loaders	61.30
Cutters	4.40
Contract labor	65.70
Inside daymen	
Mine foreman	.20
Asst. mine foreman	.61
Fire bosses	1.22
Roadman	3.46
Day laborers	6.35
Bratticeman	1.02
Wireman	.81
Pumpers	1.02
Drilman	.40
Machine repairman	.61
Section foreman	2.24
Total	17.94
Haulage	
Motor boss	.20
Motormen	3.26
Motor brakeman	3.26
Total	6.72
Total inside labor	90.36

Outside	Per cent
Labor foreman	.20
Clerk	.20
Garbage man and wash house	.20
Laborers	3.99
Electrician	.20
Sub. station	.61
Blacksmiths	.40
Car repairman	.40
Carpenters	.20
Tippleman	1.02
Machinist	.40
Hoist engineer	.20
Supply clerk	.20
Teamster	.20
Fireman	1.22
Total outside day labor	9.64

Table 5.- Operating Labor and Material Costs in percentage

	Labor	Material	Percentage of total cost
Mining	66.84	14.07	58.83
Haulage.	13.09	33.63	15.95
Timbering.	0.25	17.32	2.74
Ventilation. . . .	2.44	2.90	2.44
Tipple	3.01	2.17	2.92
Drainage	1.55	5.10	1.99
Deadwork	0.86	0.98	0.81
Power.	3.61	11.19	5.38
Mine office. . . .	8.35	12.64	8.94
Total. . . .	100.00	100.00	100.00

Efficiency Data

Cutting machines, two men on crew, tons per shift	271.72
Tons produced per pound of explosive.	10.49
Tons of coal per linear foot of timber used	1.34
Tons of coal produced per post used	8.34
Tons per man underground per shift.	6.67
Tons of coal produced per miner per shift	10.1

Tons of coal produced per dayman	19.66
Tonnage of coal delivered to hoisting shaft	2,989
Total ton-miles of work performed	8,501.8
Total ton-miles of work performed on main haulage	7,062
Average length of main-line haulage	1.19 miles
Total ton-miles of work performed on gathering haulage	1,439.8
Length of gathering haulage	700 to 2200 feet
Ton-miles of work per ton of coal produced	2.85
Number of times each car was loaded per shift	2.25
Tons of coal carried by each mine car	2.25
Average tonnage per gathering locomotive	266
Average number of cars gathered per gathering locomotive	118.25
Average number of miners served per gathering locomotive	24.66

Underground Management and Pay System Used.- All employees are under the direct control of the mine foreman, and their work is supervised by assistant foremen and section bosses who are paid on a monthly basis. All other employees are paid on a day or contract rate, and no bonus is paid any employee. The cutters and miners only are paid on a tonnage and yardage rate. The yardage rate is paid on narrow work, and for work where clay veins or spars are encountered, as a remuneration for narrow work and variations from normal conditions in wide work, but not as a bonus. No particular task to constitute a day's work is assigned to any underground employee.

If a system were installed whereby the cutting and blasting could be performed on the off shift, thus giving the miner a day's loading each day without delays due to cutting and blasting, a higher tonnage rate per man employed might be accomplished.

Accidents.- During the year 1928, 511,879 tons of coal was produced in 230 working days, 448 men were employed underground, and there were 68 lost-time accidents. A total of 290 days was lost due to accidents, which are attributed to the following causes: Falls of roof and coal, 12, or 17.65 per cent; haulage, 23, or 33.82 per cent; electricity, 2, or 2.94 per cent; mining machines, 2, or 2.94 per cent; timbering, 1, or 1.47 per cent; and miscellaneous causes, 28, or 41.18 per cent. The following table shows tons produced per accident:

Table 6.- Tons Produced Per Accident.

Cause	No. of accidents	Total days lost	Tons per accident
Falls of roof and coal	12	77	42,656.58
Haulage	23	98	22,255.6
Electricity	2	6	255,939.5
Mining machines	2	3	255,939.5
Timbering	1	14	511,879
Miscellaneous causes	28	92	18,281.4
Total	68	290	7,526.3

Safety.- This mine is classed as a gassy mine, and therefore approved electric cap lamps are used by the employees, who are charged at the rate of 4 cents per day for this service. The supervising officials use approved flame safety lamps, also all mining machine crews have a flame safety lamp. At the shaft bottoms and at important points on the haulage, 250-volt electric lights are used, for which the power is taken from the trolley lines.

At this time no rock-dust has been used in this mine, although its use is being contemplated in the near future.

It is strictly against the orders of the management to withdraw or recover posts to make falls.

Safety meetings are frequently held where all employees are invited to discuss method of accident prevention and efficiency in operating methods. These meetings no doubt have been of great assistance in obtaining the record achieved by this company, which has produced over six million tons of coal without a fatality and which in 1927 was awarded the honor certificate of the Joseph A. Holmes Society.

Inspection.- Fire bosses are employed who examine each working place for anydangerous conditions, once before the men go on shift and once while they are at their working places, and who report their findings in the daily report book.

The working places are also visited at least twice each day or oftener by the section boss, who fires the shots and instructs the miners in their work, besides examining for dangerous conditions that may arise during the shift; districts are arranged so that a section boss under no condition has more than 30 face men in his section.

Blasting.- Permissible explosives are used, fired electrically by the section boss who carries the detonators to the miners and personally inspects and tamps the shot holes. Clay is used for tamping, and the cuttings are scraped from under the mining before blasting.

Trolley Lines.- The trolley lines are well guarded at all important places by means of boards supported by anchors in the roof.

Tracks.- The tracks are well lined and graded, and ample clearance is provided on both sides. Points of switches and frogs are guarded and blocked to prevent haulagemen from getting their feet caught. Switch throws are provided that lie close to the floor at all main haulage switches; on room turnouts bridles are provided to throw both switch points at the same time.

Manways.- Manways are provided so that the employees may go to and from their working places without traveling on the haulageway.

Telephones.- Telephones are placed at important points throughout the mine.

First Aid.- A quantity of first-aid material with stretcher and blankets is kept at the station at the shaft bottom for use in case of an accident.

Motor Barn.- A well-equipped and fireproof motor barn is provided near the shaft where repairs may be made on machines and locomotives.

Summary.- There are several features at this mine that are especially commendable.

1. The whole organization seems to work together to prevent accidents and to produce the required tonnage with least cost and friction. The practice of dividing the sections so that a section boss, who also does the tamping and shot-firing, does not have more than 30 face men is one well worthy of consideration at other operations.

2. The methods of supervision employed are without doubt the best employed in any of the 20 mines visited by the writer in western Pennsylvania. A section boss or other supervising official is on hand at all times to take care of any emergency that may arise.

3. The mechanical equipment is modern, kept well guarded, and maintained in good condition.

4. The mining method employed gives good results as far as roof control is concerned. However, a break line extending through several pairs of butt entries would help to improve the present practice, which allows the entry stumps and chain pillars to lag far behind, thus leaving small isolated districts with few men employed in them, a practice which would not be possible in places where the cover was heavy and roof control was a factor in obtaining a high recovery. However, no signs of squeeze or crushing of pillars were noticed in any part of the mine.

5. The haulage is mechanical throughout; the cars are delivered to the room necks by locomotives, and are handled from there to the face by the miners. When the grade is against the load, the cars are hauled from the face by crab-reel gathering locomotives. The tracks are kept clean and in good condition.

6. From the amount of water being pumped each 24 hours it can readily be seen that the mine is damp. However, the drainage system is so planned that there are no standing bodies of water either at the faces or on the haulageways and manways.

7. Where necessary on the haulageways roof support is supplied by 8 by 6 inch square timbers and 40 or 60 pound rails. The method of posting used in rooms and pillars is adequate for the requirements of the roof. However, the employment of a good-sized cap piece 18 inches long, 4 inches thick, and

wide enough to cover the post would be an improvement, as would the employment of the vibration method of roof testing. The practice of not recovering posts to make falls eliminates any chance of accident from this cause.

8. The ventilation is good at all places. Permanent overcasts and stoppings are being built as the work advances.

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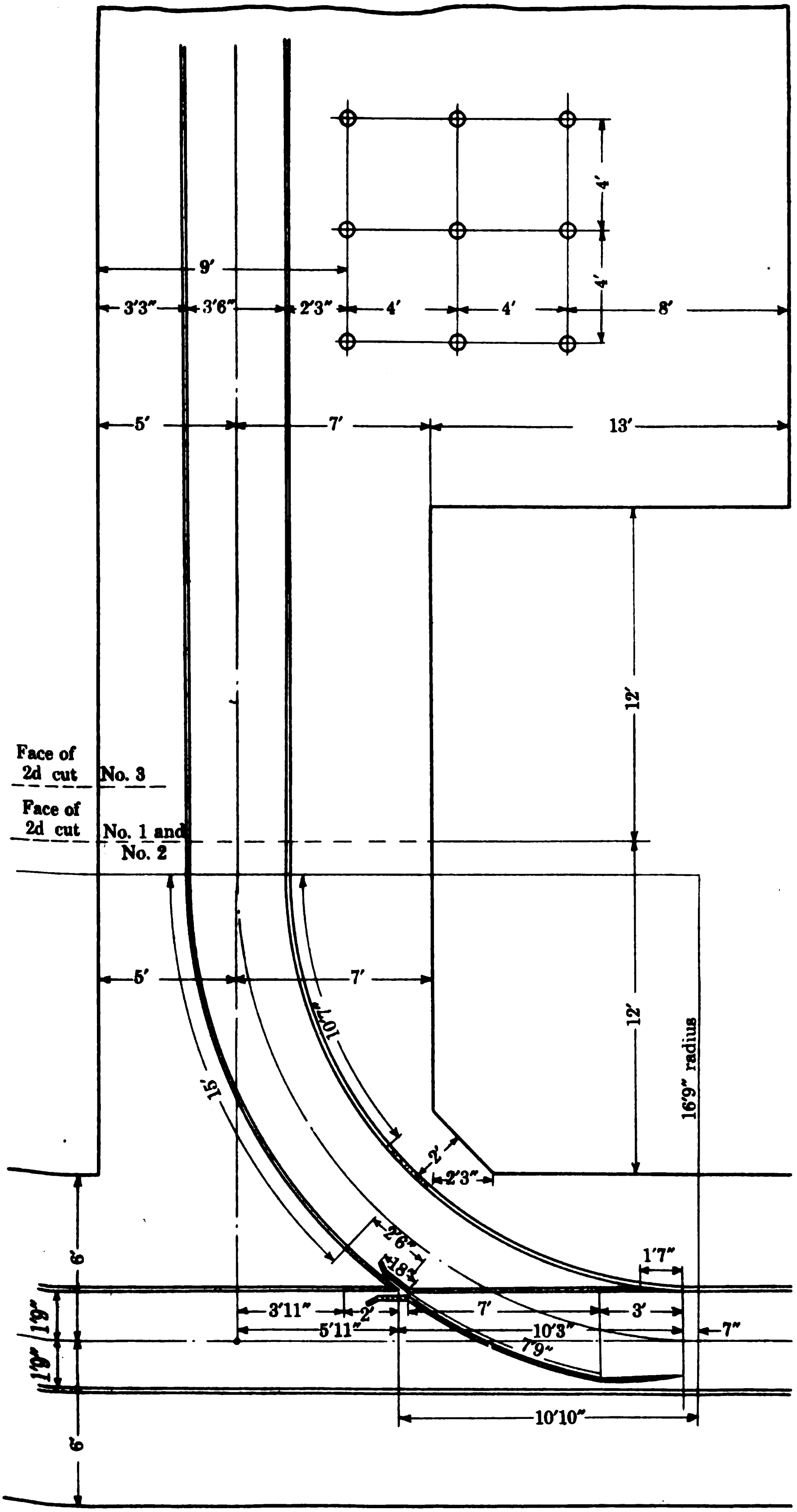

Figure 15.– Radius and detail of track curves leading into rooms